leaves, and twelve types are recognized and discussed. The concluding chapter contains a summary and some concluding remarks.

As might be supposed the author inclines to teleological views, holding that plant structures harmonize with their environment and even tend to become modified in advantageous ways. The volume will have somewhat the function of an encyclopedia, and it is therefore to be regretted that there is no index to genera.—H. C. COWLES.

MINOR NOTICES.

A REVISED EDITION of COULTER'S *Plant Structures*,[3] an elementary text-book of plant morphology, has appeared, the first edition having been published in 1899. There are numerous changes that deal with misstatements, illustrations, changed points of view, and recent discoveries so far as these have to do with the purpose of so elementary a book. Such subjects as mycorhiza, the development of the sporophyte of bryophytes, and the endosperm of angiosperms have been rewritten, and the topic of "double fertilization" introduced.

HELEN EASTMAN[4] has written a fern book for amateurs, which is intended to be "an illustrated field-book that shall be concise, inexpensive, and adapted to the needs of the beginner." The photographs for the plates are said to have been "produced by an entirely original process." The general purpose of such books is to be commended, in so far as they stimulate interest in plants or help to make observation somewhat definite. Doubtless the present book will serve its purpose well in New England.—J. M. C.

ATKINSON[5] has published an outline of his lectures on plant ecology as delivered at Cornell University and they will be of value to all teachers who give ecological courses or who introduce ecological features into general courses. After general lectures on the plant organization, plant organs are considered, then ecological factors, vegetation types, migration. Several lectures on the various formations or societies conclude the series.—H. C. COWLES.

NOTES FOR STUDENTS.

HITCHCOCK,[6] in a short address on the control of sand dunes in the United States and Europe, gives an account of the European methods of dune control, and makes suggestions for similar work in this country.—H. C. COWLES.

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[3] COULTER, JOHN M., Plant Structures. Second edition revised. 12mo. pp. ix+348. *figs. 289*. New York: D. Appleton and Company. 1904.

[4] EASTMAN, HELEN, New England ferns and their common allies; an easy method of determining the species. 12mo. pp. xix+161. Boston: Houghton, Mifflin & Co. 1904.

[5] ATKINSON, G. F., Relation of plants to environment (or plant ecology). Outlines of course of lectures delivered in the Summer School of Cornell University 1903 and 1904. pp. 67. Ithaca Publishing Co., Ithaca, N. Y.

[6] HITCHCOCK, A. S., Controlling sand dunes in the United States and Europe. Nat. Geog. Mag. **1904**:43–47.

COSTERUS and SMITH[7] have begun the publication of an account of numerous "monstrosities" observed in the Botanical Gardens of Buitenzorg and elsewhere in the tropics. This is in continuation of a paper published in the same journal in 1895 (p. 97), and deals with monocotyledons. In a subsequent paper dicotyledons and a few cryptogams will be presented.—J. M. C.

POSTGLACIAL fossils have been too much neglected by American paleobotanists. There seems to be no reason why the magnificent results that have been obtained by the Scandinavian investigators should not be duplicated here. PEHR OLSSON-SEFFER[8] has given an account of the methods of bog study (telmatology)employed by Andersson, Sernander, and other Swedish workers.—H. C. COWLES.

SHAW[9] has found that the stamens of Sanguinaria pass the winter in the mother-cell stage; that in Sanguinaria, Chelidonium, and Eschscholtzia there is a stylar canal; that in all three genera the antipodals are very prominent; and that in Sanguinaria and Eschscholtzia the testa is developed from the inner part of the outer integument, while in Chelidonium it is developed from both integuments.—J. M. C.

BOODLE[10] has discovered that a reduced secondary xylem occurs in the stems (both subterranean and aerial) of Psilotum, outside of the solid mass of tracheids described by Bertrand and internal to the ring of sieve tubes. In the lower region of the aerial stem a few cases of apparent mesarch structure were observed. The results strengthen the hypothesis of the affinity of the Psilotaceae with the Sphenophyllales.—J. M. C.

IN A PRESIDENTIAL address before the Linnean Society of New South Wales MAIDEN[11] devotes attention, among other things, to a botanical survey of the country. He suggests a scheme for dividing New South Wales into a number of botanical counties or domains, and gives a list of the most important and accessible papers dealing with each. A plea is made for an ecological study along physiographic lines.—H. C. COWLES.

W. L. BRAY has given an interesting anatomical account of some of the plants of the xerophytic regions of Texas.[12] A study was made of *Agave Lecheguilla*.

[7] COSTERUS, J. C., and SMITH, J. J., Studies in tropical teratology. Ann. Jard. Bot. Buitenzorg II. **4**:61–85. *pls. 8–11.* 1904.

[8] OLSSON-SEFFER, P. Examination of organic remains in postglacial deposits. Amer. Nat. **37**:785–797. 1903.

[9] SHAW, CHARLES H., Note on the sexual generation and the development of the seed-coats in certain of the Papaveraceae. Bull. Torr. Bot. Club **31**:429–433. *pl. 15.* 1904.

[10] BOODLE, L. A., On the occurrence of secondary xylem in Psilotum. Annals of Botany **18**:505–517. *pl. 33.* 1904.

[11] MAIDEN, J. H., Presidential address. Proc. Linn. Soc. New South Wales **1902**:740–804.

[12] BRAY, W. L., The tissues of some of the plants of the Sotol region. Bull. Torr. Bot. Club **30**:621–633. 1903.

Hesperaloe parviflora, *Nolina texana*, *Ariocarpus fissuratus*, and *Euphorbia antisyphilitica*. The stomatal apparatus, in particular, was found to exhibit marked xerophytic peculiarities. In Ariocarpus there are a number of projections of the cuticular layer into the pit just above the stoma, which virtually makes a series of chambers of the pit.—H. C. COWLES.

CANNON[13] has concluded from anatomical evidence that the two species of mistleto (*Phoradendron villosum* and *P. californicum*) occurring in the vicinity of the Desert Botanical Laboratory (Tucson, Arizona) do not penetrate their hosts by means of solvents secreted by the haustoria; but "the points of admission are determined solely by the character of the host-substratum, whether its cells are loosely put together, as in the lenticels of the cottonwood, or the place where the parasite seeks admission has cellulose cell-walls."—J. M. C.

STAPF[14] has published an account of his studies of the fruit of Melocanna, which is peculiar among grasses in being very large and having a fleshy pericarp. The three species are restricted to India, and the fleshy character of fruit or seed is shared with Melocalamus and Ochlandra. Endosperm is developed only as a delicate parietal tissue, which is soon resorbed by the much enlarging scutellum, the food reserve in the mature fruit being in the fleshy pericarp and the scutellum. Additional facts of interest are that the ovule develops no integuments and that vivipary is an established habit.—J. M. C.

MISS ROBERTSON[15] has studied material of *Torreya californica* from plants cultivated in Great Britain. The microsporangia pass the winter in the mother-cell stage, and the tetrads are formed early in April. No prothallial cell was observed, and during the latter half of May the division resulting in the generative and tube nuclei occurred. Primordia of ovules were observed December 1, and early in April pollination took place. The megaspore mother-cell was not distinguished until late in May, and a month later the reduction division occurred, a linear tetrad being formed. Material did not permit following the development of the female gametophyte and embryo.—J. M. C.

HOLM[16] has been studying the roots of our terrestrial orchids. He finds that a tuberous rhizome is provided only with slender roots, while species with slender rhizomes may possess tuberous roots. The subject is treated under three heads: (1) roots slender, with the leptome and hadrome located in one central cylinder; (2) same, but roots tuberous; (3) roots tuberous, with several cylinders of lep-

[13] CANNON, W. A., Observations on the germination of *Phoradendron villosum* and *P. californicum*. Bull. Torr. Bot. Club **31**:435–443. 1904.

[14] STAPF, OTTO, On the fruit of *Melocanna bambusoides* Trin., an endospermless, viviparous genus of Bambuseae. Trans. Linn. Soc. London II. Bot. **6**:401–425. *pls. 45–48*. 1904.

[15] ROBERTSON, AGNES, Spore formation in *Torreya californica*. New Phytol. **3**:133–148. *pls. 3–4*. 1904.

[16] HOLM, THEO., The root-structure of North American terrestrial Orchideae. Amer. Jour. Sci. IV. **18**:197–212. 1904.

tome and hadrome. The results show the greatest diversity of structure, even among the most closely allied forms. An interesting observation is that while the roots of our terrestrial orchids form mycorhizas, this is not true of all the roots of the same species, nor of the same individual.—J. M. C.

WESTGATE has been making a study of the reclamation of sand dunes on Cape Cod.[17] The ecological relations of the vegetation are first treated. Ecological factors, mode of sand deposition, development of the range of dunes, natural reclamation, the vegetation of areas which receive gradual accumulations of sand, of areas which receive no such accumulations, and of marshes and bogs are briefly discussed. An account is given of the devastating effects of the dune sand on adjoining areas, and of the means that have been employed to check them. At no other place in this country have artificial plantings in dune sand been carried on so extensively or for so long a time as there.—H. C. COWLES.

BRITTON[18] has made a study of some rather extensive sand plains in the neighborhood of New Haven, Conn., especial attention being paid to the anatomy of the more typical plants. Perhaps the most characteristic species are *Andropogon scoparius* and *Juniperus virginiana*. A fact of much interest is that several species of swamp plants were found on the plains; *e. g.*, *Nyssa sylvatica*, *Aronia arbutifolia*, *Vaccinium corymbosum*, *Kalmia angustifolia*, *Ilex verticillata*, *Rosa carolina*. In the anatomical portion of the paper, particular attention is paid to the anatomy of the subterranean organs, a topic that is often superficially treated or even ignored in treatises that are otherwise satisfactory. A number of interesting details are presented, for which recourse must be had to the original.—H. C. COWLES.

STUDIES ON THE PLANT CELL is the title of a series of articles in which DAVIS[19] proposes to describe the chief structures and functions of the plant cell. The subject will be treated under the following heads: (1) structures of the plant cell; (2) the activities of the plant cell; (3) highly specialized plant cells and their peculiarities; (4) cell unions and nuclear fusions; (5) cell activities at critical periods in the ontogeny of plants; (6) comparative morphology and physiology of the plant cell. The opening paper deals with the first of these sections, under the subheads: (1) protoplasmic contents; (2) non-protoplasmic contents, and (3) the cell wall. A list of fifty-five papers is given.

While the subject is in such a condition that critical discussion or philosophical speculation is unsafe, a summary of the literature will be useful to students interested in this subject.—CHARLES J. CHAMBERLAIN.

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[17] WESTGATE, J. M., Reclamation of Cape Cod sand dunes. Bulletin no. 65, Bureau of Plant Industry, U. S. Dept. of Agric. pp. 36. *pls. 6.* 1904.

[18] BRITTON, W. E., Vegetation of the North Haven sand plains. Bull. Torr. Bot. Club **30**:571–620. 1903.

[19] DAVIS, B. M., Studies on the plant cell. Amer. Nat. **38**:367–395. *figs. 1–3.* 1904.

SINCE PARTHENOGENESIS in flowering plants has been proven in only a few genera, it is interesting to note any accessory peculiarities. In parthenogenetic species of Alchemilla, MURBECK[20] finds that the number of chromosomes remains unchanged throughout the entire life history, not showing any reduced number in the gametophytic generation. The behavior of the antipodal nuclei and synergids is also peculiar in Alchemilla, some or all of these five nuclei having the power of motion, so that they behave like polar nuclei. Consequently, it is not at all uncommon to find three or four nuclei at the middle of the sac where one expects to find the two polar nuclei. In such cases the extra nuclei clearly belong to the antipodals or synergids, these regions lacking a corresponding number. Associated with parthenogenesis in Alchemilla is the phenomenon of polyembryony, the extra embryos coming from the synergids or from the cells of the nucellus.—CHARLES J. CHAMBERLAIN.

THE CEYLON PATANAS, which may be compared to our prairies, are forming the subject of an important study by PARKIN and PEARSON.[21] In an earlier paper the junior author gave a general account of the patanas, which are grasslands situated in a region that is otherwise forested. The patanas are of two kinds: wet patanas, located above an altitude of 4500 feet, and dry patanas at a lower altitude. The present paper deals with the anatomical characteristics of their plants, and data have been collected from eighty species. As might be expected, the characters as a whole may be regarded as more or less xerophytic. The most important result is that the plants of the wet patanas are as xerophytic as those of the dry patanas; indeed the former are more hairy, and have a compacter mesophyll. The authors appear to have been surprised at this feature of their results, which, however, seems quite in harmony with the well-known xerophytic characters of the plants of peat bogs and salt marshes.—H. C. COWLES.

WILLE[22] gives the history of the generic name Gloionema, proposed in 1812 by C. A. AGARDH, and, having studied the types in AGARDH'S herbarium in Lund, WILLE shows that the specimens on which the genus was founded are eggs of some fly belonging to the Tipulidae. The genus Gloionema, the systematic position of which has been subject to much discussion, has comprised not only these "egg-specimens," but also some diatoms. Since KÜTZING (1849) used the name as a synonym only for certain diatoms, later writers have followed the example. WILLE'S object in reviewing the history of this name has been to show the errors and the confusion in nomenclature, which may result from an indiscriminate

[20] MURBECK, SV., Ueber Anomalien in Baue des Nucellus und des Embryosackes bei parthenogenetischen Arten der Gattung Alchemilla. Lunds Universitets Årsskrift **38**: no. 2. pp. 11. *pl.* 1. 1902.

[21] PARKIN, J., and PEARSON, H. H. W., The botany of the Ceylon patanas. Jour. Linn. Bot. Soc. **35**:430–463. 1903.

[22] WILLE, N., Ueber die Gattung Gloionema Ag. Eine Nomenclaturstudie. Reprint from "Festschrift zu P. Ascherson's siebzigstem Geburtstage," pp. 439–450 1904.

use of the priority rule and from an imperfect description such as AGARDH'S, which suits not only a great number of different algae within various groups, among them diatoms, red algae, Myxophyceae, and Chlorophyceae, but also insect eggs. He advocates therefore the necessity of furnishing not only a complete diagnosis, but also a good drawing of every new form of thallophytes described. —OLSSON-SEFFER.

MACDOUGAL has published several short papers that will be of interest to the readers of these notes. In a paper entitled "Soil temperatures and vegetation"[23] he gives the results of his thermographic studies, and concludes that too little attention has been paid to soil temperatures; it seems likely that diurnal and seasonal variations, and differences in the temperatures of aerial and subterranean portions must have a large influence on physiological processes, both directly and indirectly. In "Some aspects of desert vegetation"[24] and "Botanical explorations in the Southwest"[25] he gives interesting popular accounts of our deserts and their vegetation, and shows the possibilities of the Desert Laboratory in shedding light on the origin of species. "Mutation in plants"[26] is a sympathetic presentation of the mutation theory, in which the author gives the results of his own cultural studies. The mutants have in all respects the specific characteristics of their Holland prototypes. "Some correlations of leaves"[27] deals with the results obtained in the further development of the shoot and leaf, when resort is had to defoliation. Extra development was awakened in stipules and other organs.—H. C. COWLES.

WILLE and WITTROCK[28] submit to the next International Botanical Congress at Vienna the following propositions: I. In order to establish the right of priority for new species and morphological varieties among the thallophytes, it will be necessary to publish in the future not only a description, but a figure of the organism under consideration, sufficiently clear to make the diagnosis of the species understood. II. In order to maintain the right of priority for new genera among the thallophytes, besides the description there shall also be published (or referred to) a figure of at least one species among those comprising the genus considered. III. These resolutions shall be in force from the first of January 1906. The most beneficial results that would be obtained if these proposals were accepted would be that the identification would be considerably aided by having figures to refer to; such figures would in the future be executed with greater exactness in

[23] Contrib. N. Y. Bot. Gard. no. 44. Mo. Weather Rev. Aug. 1903.

[24] Contrib. N. Y. Bot. Gard. no. 46. Plant World **6**:249–257. 1903.

[25] Jour. N. Y. Bot. Gard. **5**:89–98. 1994.

[26] Contrib. N. Y. Bot. Gard. no. 48. Amer. Nat. **37**:737–770. 1903.

[27] Contrib. N. Y. Bot. Gard. no. 43. Bull. Torr. Bot. Club. **30**:503–512. 1903.

[28] WILLE, N., and WITTROCK, V., Motion au Congrès international de Botanique, Deuxième Session, Vienne 1905. Nyt Magasin Naturvidenskaberne **42**:217–220. 1904.

order to maintain the right of priority; characters would be more carefully observed, and better diagnoses would be obtained; provisional descriptions, which only tend to confuse the right of priority and are more or less incomplete, would be avoided.—OLSSON-SEFFER.

PRIANISCHNIKOW[29] considers CZAPEK'S conclusion,[30] that no free acid but carbonic is secreted by roots, to be not justified by the experiments. His objections to CZAPEK'S work are, first, that the assertion that aluminum phosphate is insoluble in acetic acid is incorrect; second, that the aluminum phosphate used was not pure, the presence of the hydrate decreasing the solubility; third, that water affected the surface of the gypsum plates used. By using sand mixed with pure iron and aluminum phosphates, the author found that the phosphates were absorbed by the plants, and concluded that root secretions contain organic acids capable of dissolving aluminum and iron phosphates. The solution of phosphates varied with different plants. If it can be proved that carbonic acid secretion varies in consonance with the solution energy of the root system of various plants, and that aluminum and iron phosphates are dissolved by carbonic acid, then there is no need to suppose the presence of other organic acids than carbonic in root secretions. The presence of acid phosphates in the root secretions of seedlings may be explained by the fact that in germination, decomposition of proteid is in excess of synthesis, and the phosphorus set free may be, in part, secreted as phosphates.—L. M. SNOW.

BLACKMAN[31] has discussed the relation of fertilization, apogamy, and parthenogenesis, closely analyzing the processes indicated by these terms. The fact is emphasized that the process of fertilization is almost impossible of definition, in which opinion all biologists will probably concur. In "typical exogamous fertilization," with its fusion of gametes from different individuals, three results at least are apparent: (1) a stimulus to further development; (2) a mingling of two lines of descent; and (3) a doubling of chromosomes. Starting with this primitive type, a series of reduced processes is indicated in which one or more of these characteristic results of fertilization have been lost. For example, "self-fertilization," common among angiosperms, no longer brings about the mingling of different hereditary properties; and cases of apogamy preceded by nuclear fusion is a still more reduced form of fertilization in the same direction. Many of the so-called cases of parthenogenesis are regarded as still further cases of reduction of the primitive process, for there has not even been the formation of a potential egg, in the sense that there has been a reduction division. In this sense, it is claimed that true parthenogenesis has not been proved among the higher plants. Since there is no reduction division, there is no true gamete, and the

[29] PRIANISCHNIKOW, D., Zur Frage über die Wurzelausscheidungen. Ber. Deutsch. Bot. Gesells. **22**:189–190. *pl. 12.* 1904.

[30] CZAPEK, Jahrb. Wiss. Bot. ————————. 1896.

[31] BLACKMAN, VERNON H., On the relation of fertilization, "apogamy," and "parthenogenesis." New Phytol. **3**:149–158. 1904.

resulting embryo is really a case of sporophytic (somatic) budding. In such cases the reduction of the primitive process of exogamous fertilization is complete; the mingling of different characters, the stimulus to development, and the doubling of chromosomes all having disappeared.—J. M. C.

BRAY[32] finds that according to their character and distribution the forests of Texas are to be classified as the east Texas timber belt, the timbered area of Edwards plateau, the live oak timber belt, the Rio Grande plain chaparral, the mesquite, and the timber of the Cordilleran region. According to the habitat of its different components, the eastern timber belt is subdivided into the following types: the swamp and bayou forests, the hardwood forests of the alluvial bottoms, the mixed hardwood forest of the interior of the coast plain, the long-leaf forests of the Fayette prairie, and the hardwood and short-leaf forests of the lignitic belt. Under each of these headings follows a brief but very careful analysis of the factors determining the present condition of the tree growth in each forest type. From the economic standpoint the bulletin shows that only 10 per cent. of the entire area of Texas is covered with a merchantable forest; 125,000 acres, yielding nearly a billion feet of lumber, are being cut over annually. The timber is cut in such a way that the land does not reproduce valuable forests. The author gives valuable and timely suggestions in regard to forest management both for private owners and for the state.

The same author[33] has studied the forests of the Edwards plateau with special reference to their relation to the water supply. The plateau is composed of limestone, and the naturally high water-absorbing capacity of the rock is enhanced by the position of the strata and by the numerous extensive fissures and caverns. Thus the region forms a vast catchment area for the water which supplies the agricultural lands below. The rapid collection and run-off of the waters from the bare slopes cause frequent disastrous floods. The writer shows how covering the slopes with tree growth (which is rapidly taking place naturally) tends to reduce both the frequence and the eroding power of the floods. By conserving the waters of the plateau in this manner they could be used to irrigate the rich but arid lands of adjacent plains. State ownership for this purpose is recommended.

These two bulletins are valuable contributions to our knowledge of the life-relations of trees, and they demonstrate the value of careful ecological study in dealing with certain problems of practical forestry —CLIFTON D. HOWE

ITEMS OF TAXONOMIC INTEREST ARE AS FOLLOWS: CARL MEZ (Bull. Herb. Boiss. II. 4:619–634. 1904) has published new species of Bromeliaceae in Greigia, Aechmea (2), Billbergia, Pitcairnia (9), and Puya (7).—O. VON SEEMEN (*idem*

[32] BRAY, WILLIAM L., Forest resources of Texas. U. S. Dept. Agric., Bureau of Forestry. Bull. no. 47. 1904.

[33] BRAY, WILLIAM L., The timber of the Edwards plateau of Texas; its relation to climate, water supply, and soil. U. S. Dept. Agric., Bureau of Forestry. Bull. no. 49, 1904.

651–656) has published two new species of Quercus from Costa Rica.—A. THEILUNG (*idem* 695–716), in the first of a series of studies of Lepidium, has replaced the *L. virginicum* of American authors by *L. densiflorum* Schrad., has disentangled from the same confused mass of forms the new species *L. neglectum*, and has described a new related species (*L. costaricense*) from Costa Rica.—C. A. M. LINDMAN (Arkiv for Botanik **1**:7–56. 1904) has published a critical review of the American species of Trichomanes, based on collections in Swedish herbaria and on specimens obtained by the author in Brazil, 3 new species being described; and has also (*idem* 187–276) published an account of a collection of Brazilian ferns containing 16 new species.—M. L. FERNALD (Rhodora **6**:162. 1904) has published a new species of Alnus (*A. mollis*) from Canada and adjacent Eastern United States.—E. P. BICKNELL (Bull. Torr. Bot. Club **31**:379–391. 1904), in presenting the Californian species of Sisyrinchium, has described 5 new species.—P. A. RYDBERG (*idem* 399–410), in his 11th "Studies on the Rocky Mountain flora," has described new species of Juncus (3), Juncoides, Allium (2), Corallorhiza Salix, Atriplex (2), Corispermum, Claytonia, Cerastium, Arenaria (3), Alsinopsis, Lychnis, Stanleya, and Schoenocrambe.—N. PATOUILLARD (Bull. Soc. Mycol. France **20**:136. *fig. 1.* 1904) has described a new genus (*Seuratia*) of Capnodiaceae on the leaves of the coffee plant.—H. HARMS (Ann. Jard. Bot. Buitenzorg II. **4**:13–16. 1904) has described a new East Indian genus (*Anomopanax*) of Araliaceae, comprising 3 species.—S. H. KOORDERS (*idem* 19–32. *pls. 2–3*) has described a new genus (*Teijsmanniodendron*) of Verbenaceae under cultivation, its nativity being unknown.—G. R. SHAW (Gard. Chron. III. **36**: 122. *fig. 49.* 1904) has described a new pine (*P. Nelsoni*) from northeastern Mexico.—W. A. MURRILL (Bull. Torr. Bot. Club **31**:415–428. 1904), in his eighth paper on the Polyporaceae of North America, has presented Hapalopilus and Pycnoporus, and described 6 new monotypic genera (*Abortiporus, Cyclomycetella, Cycloporus, Globifomes, Nigrofomes*, and *Poronidulus*).—N. L. BRITTON (Torreya **4**:124. 1904) has described a new species of Alnus from New York.—J. M. C.

BLAKESLEE has published in full[34] the results of his studies upon the sexual reproduction in the Mucorineae first announced in *Science* June 3, 1904. This brilliant work has completely revolutionized our views of the conditions that influence the production of zygospores. While most investigators have been trying to determine external factors such as increased humidity, high temperature, seasonal conditions, etc., as the stimuli to zygospore formation, BLAKESLEE finds that it "is conditioned primarily by the inherent nature of the individual species and only secondarily by external factors."

BLAKESLEE shows that the Mucorineae fall into two groups. The first, termed the homothallic group, comprise "the minority of species (ex. Sporodinia) and form their zygospores from branches of the same thallus or mycelium, and can be obtained from the sowing of a single spore." The second group, termed

[34] BLAKESLEE, A. F., Sexual reproduction in the Mucorineae. Proc. Am. Acad. **40**:205–319. *pls. 4.* 1904.

heterothallic, contains a large majority of the species (ex. Rhizopus, Mucor, Phycomyces), each of which is made up of two sexual strains, so that the "zygospores are developed from branches which necessarily belong to thalli or mycelia diverse in character and can never be obtained from the sowing of a single spore. . . . . Every heterothallic species is, therefore, an aggregate of two distinct strains, through the interaction of which zygospore production is brought about."

These sexual strains show in general a greater or less vegetative luxuriance and are designated by the + and − signs respectively. The two strains only form zygospores when growing together, as the progametes "arise from the stimulus of contact between the more or less differentiated hyphae (zygophores) and are from the outset always normally adherent."

"A process of imperfect hybridization will occur between unlike strains of different heterothallic species in the same or even in different genera," *i. e.*, the gametes are formed by the chemotactic stimulus of contact with the mycelium of an opposite strain. This peculiarity makes it possible to determine the strain of an unknown form by cultivation with the strains of determined material and is most interesting as evidence that the stimulus to zygospore formation is chemical rather than the rougher physical conditions. These attempts at hybridization were not observed to go farther than the cutting off of the two gametes.

BLAKESLEE concludes from his studies: (*a*) that the formation of zygospores is a sexual process; (*b*) that the mycelium of a homothallic species is bisexual; (*c*) that the mycelium of a heterothallic species is unisexual; and further (*d*) that in the + and − series of the heterothallic group the two sexes are represented.—B. M. DAVIS.

THE CONDITIONS influencing the production of zoospores in Chlamydomonas have been studied by FRANK,[35] who shows that a decrease in concentration of Knop's solution acts as a stimulus, as does also, but in a secondary way, decrease in light intensity. Temperature limits were also studied, with the conclusion that this factor is only a secondary one in the production of zoospores. The alga bears concentrations up to 2.5 per cent. Knop's solution. In the higher concentrations the cells are larger and their contents more dense. On solid substrata soaked with solution the plant behaves much as in a more concentrated solution. The transfer of cells from Knop's solution to solutions of various single chemical salts influences the production of zoospores variously according to the salt used. Thus, as has been shown before, K is somewhat more poisonous than Na. With all the salts used a concentration is soon obtained wherein no zoospores are produced. The osmotic pressure of the solution at this concentration-limit sometimes lies above, sometimes below, and sometimes is equal to that of the limiting concentration for Knop's solution. From this the author concludes that the stimulus producing zoospores is not an osmotic one when the mere reduction of concentration in the nutrient medium is involved. I cannot

[35] FRANK, THEODOR, Cultur und chemische Reizerscheinungen der *Chlamydomonas tingens*. Bot. Zeit. **62**[1]: 153–188. *pl. 6.* 1904.

see how this follows, for in all the simple solutions used there was a lack of the other salts normally present in the Knop's solution. Thus, in the study of these poisons more than one factor has been varied. The strengths of solution used are throughout stated in percentages, and the obsolete method of isotonic coefficients is used in calculating osmotic pressures, so that it will be necessary to transform the data to more modern terminology before they can be of wide use in comparison. The methods and terminology of physical chemistry are most suitable for this sort of investigation. The general results of this part of the paper are as follows: Production of new motile cells can take place only with a reduction of the concentration of the medium. The process is checked by the presence of many substances, and these act chemically rather than osmotically, *i. e.*, they act like poisons.

The zoospores of this alga are positively phototactic towards blue light of not too great intensity, but after a limiting intensity is passed they are negatively so. They are sensitive to very weak light. It would be well if such observations as these could be made with a photometer, such as a silver salt perhaps, so that limits of light intensity might be definitely stated. The chemotactic responses of these same cells were also investigated, as were also those of *Euglena gracilis*, but the results cannot be stated here.—B. E. LIVINGSTON.

THE EXPERIMENTAL morphology of *Achlya polyandra* has been studied, albeit in a somewhat medieval way, by HORN,[36] working in KLEBS's laboratory at Halle. He shows that the presence of metals in the nutrient medium, as well as of traces of metallic salts, has a marked effect on both vegetative and reproductive activity of this organism. In such media the hyphae, which are normally without cross walls, develop such walls, often at regular intervals, and the filament often becomes divided up into polyhedral chambers, like irregular parenchyma, by walls in all directions. The same effect is brought about by partially plasmolyzing healthy hyphae and then returning them to the normal medium. But there appears to be a difference in the nature of the cross walls in these two cases; those produced by a metal are not doubly refractive and consist largely of pectin, while those produced by plasmolysis are anisotropic and contain much cellulose. However, the latter form of walls is at first exactly like the former; the difference appears later. The general response of the plant is quite parallel to that which I have obtained in Stigeoclonium,[37] the formation of cross walls

[36] HORN, L., Experimentelle Entwicklungsänderungen bei *Achlya polyandra* de Bary. Ann. Mycol. **2**:207–241. *figs. 21.* 1904.

[37] For the effect of external osmotic pressure upon Stigeoclonium see LIVINGSTON, B. E., On the nature of the stimulus which causes the change of form in polymorphic green algae. BOT. GAZ. **30**:361–377. *pl. 22.* 1900. Also, Further notes on the physiology of polymorphism in green algae, *ibid.* **32**:292–302. 1901. The recent work on the effect of metallic salts upon this same plant was reported in part at the St. Louis meeting of the Am. Ass. Adv. Sci., Dec. 1903. See Science N. S. **19**:173. 1904. The fuller discussion of this subject is about to be published in the Bull. N. Y. Bot. Garden.

and of irregular division being quite parallel to the production of the palmella form in my alga, which is brought about by many metal salts as well as by high osmotic pressure of the medium. Perhaps if HORN's poisoned material had been transferred to a normal medium at an early stage in the development of cross walls the same cellulose formation would have occurred as that which he observed in the partially plasmolyzed filament.

Regarding the production of zoospores, the unsatisfactory and almost meaningless general observation is made again, as it has been made with other forms, that these bodies are produced "when a sufficient amount of nutrient material for growth is no longer present in the medium." This is of course not exact science. They are produced at a temperature of from 5° to 31° C. "Osmotic pressure has only an indirect effect." Intercalary sporangia are produced in the filaments poisoned with metal and also in those which have been partially plasmolyzed for a short time; indeed, all the cells of the parenchyma-like masses above described seem to be potential sporangia. This last observation seems to agree quite accurately with that made in the case of Stigeoclonium, that palmella cells are capable of producing zoospores when in weak media, whether the plant has been brought to this form by metallic poison or by external osmotic pressure.

These are the main results of the paper. It is to be regretted that good experimentation should be brought to so little account by such vagueness of thought as indicated in the adoption of NÄGELI's theory of the oligodynamic effect of metals, which has no real basis in experiment, and the idea that nutrition is somehow a thing apart from chemical stimulation and response. The present paper appears to "strike only the high places," as the phrase goes. What is needed in physiological work is more of the methods of the physical chemist.—B. E. LIVINGSTON.

LAWSON[38] has published the results of his investigation of *Cryptomeria japonica*, concerning which we have had heretofore only ARNOLDI's somewhat meager account. The material was obtained chiefly from trees growing on the campus of Stanford University. The staminate cones appear early in October, the reduction division occurs the first week of November, and by December the microspores are rounded off. In January the first nuclear division takes place, resulting in generative and tube nuclei, no prothallial cell being formed. Pollination occurs during the latter part of February, and the pollen tubes, without branching, advance directly towards the embryo sac. The generative nucleus divides early in the pollen tube development, and the body cell becomes very large, consorting with the tube- and stalk-cell nuclei in the tip of the tube. About the middle of June the male cells are formed and fertilization occurs.

Deep in the nucellus three or four mother-cells become differentiated early in March, each giving rise to a tetrad. The centrally placed megaspore of the twelve to sixteen potential ones functions, the development of the female gamet-

[38] LAWSON, A. A., The gametophyte, fertilization, and embryo of *Cryptomeria japonica*. Annals of Botany **18**:417–444. *pls. 27–30*. 1904.

ophyte proceeding as usual, so far as parietal placing and centripetal growth are concerned. The method of forming the permanent endosperm tissue is remarkable, and is either unusual among gymnosperms or has escaped observation. The primary endosperm cells, that is those open towards the center of the sac, elongate inward, and free nuclear division proceeding they become multinucleate. Then comes a stage when "hundreds of the free nuclei divide about the same time," but no cell plate is formed between the daughter nuclei, the kinoplasmic fibrils extending between them increasing in number and curving outwards on all sides until both nuclei are completely surrounded by a sheath of fibrils which fuse, thus forming an investing membrane. This method of free cell formation goes on throughout the whole of the prothallium except in the region of the archegonium initials, the cells becoming crowded and thus resembling ordinary tissue composed of binucleate cells. After this tissue has been organized nuclear division with cell plates proceeds in the usual way.

The archegonium initials were observed about May 25, and eight to fifteen archegonia are organized into a complex invested by a common layer of jacket cells. The neck cells are usually four in number, and just before fertilization the nucleus of the central cell divides into ventral canal and egg nuclei, without the formation of any separating membrane. Only one male cell enters an egg, two eggs thus being fertilized from one tube, and the male nucleus is liberated from its cytoplasmic sheath only after the male cell has become imbedded in the egg cytoplasm.

The proembryo begins with the formation of four free nuclei, in one case six being observed, which pass to the base of the egg and begin the divisions that result in the two tiers of cells and four free nuclei. The cells of the upper tier elongate to form the long and tortuous suspensor, and one or several embryos may be developed from a single egg. The estimated but not definitely counted number of chromosomes was nine or ten for the gametophyte and eighteen or twenty for the sporophyte.

The general conclusion is reached that the structures of Cryptomeria are distinctly of the Cupresseae type.—J. M. C.